Examiner's Copy

AN 126:160237 HCA
TI Composite rolls with iron alloy cast surface having high wear resistance and surface quality
IN Nishimura, Osamu; Myasaka, Yoshikazu
PA Yodogawa Steel Works, Japan
SO Jpn. Kokai Tokkyo Koho, 9 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	JP 08325673	A2	19961210	JP 1995-133201	19950531
	JP 3028514	B2	20000404		

AB The rolls have, on steel cores, Fe alloy outer layers contg. C 1.0-2.5, Si 0.3-1.5, Mn 0.3-1.5, Cr 4.0-8.0, Mo 4.0-8.0, V 3.0-8.0, W 2.0-6.0, Nb 0.1-2.0, Co 0.5-8.0, Al 0.05-0.5, B 0.05-0.5, and N 0.02-1.0 wt.%. The rolls are esp. suitable for use in hot strip mills.

0.05-0.5 B
1-2.5 C
4-8 Cr
4-8 Mo
2-6 W
0.1-2 Nb
3-8 V
0.5-8.0 Co
0.3-1.5 Mn
Fe

≤0.05-8 P
≤0.03% S

[0019]

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 08-325673

(43)Date of publication of application : 10.12.1996

(51)Int.Cl. C22C 38/00
C22C 38/32
// B22D 19/16

(21)Application number : 07-133201

(22)Date of filing : 31.05.1995

(71)Applicant : YODOGAWA STEEL WORKS LTD

(72)Inventor : NISHIMURA OSAMU
MIYASAKA YOSHIKAZU

(54) COMPOSITE ROLL FOR ROLLING EXCELLENT IN WEAR RESISTANCE, SURFACE ROUGHENING RESISTANCE AND THE LIKE

(57)Abstract:

PURPOSE: To improve the wear resistance, surface roughening resistance and the like of a composite roll for rolling in which an external layer (roll barrel part) is cast around shaft material made of steel by build-up welding.

CONSTITUTION: The external layer is formed of the following ferrous alloy: the one contg. 1.0 to 2.5% C, 0.3 to 1.5% Si, 0.3 to 1.5% Mn, 4.0 to 8.0% Cr, 4.0 to 8.0% Mo, 3.0 to 8.0% V, 2.0 to 6.0% W, 0.1 to 2.0% Nb, 0.5 to 8.0% Co, 0.05 to 0.5% Al, 0.05 to 0.5% B, 0.02 to 1.0% N, and the balance substantial Fe. As the combined effect by Al, B and N, the cast structure of the external layer is refined and homogenized, and by hardening and tempering treatment, its improved wear resistance, surface roughening resistance and the like can be secured.

LEGAL STATUS

[Date of request for examination] 13.05.1996

[Date of sending the examiner's decision of rejection] 06.10.1998

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number] 3028514

[Date of registration] 04.02.2000

[Number of appeal against examiner's decision of rejection] 10-17725

[Date of requesting appeal against examiner's decision of rejection] 05.11.1998

[Date of extinction of right]

CLAIMS

[Claim(s)]
[Claim 1] In the roll for rolling which has the composite construction by which the outer layer which is a roll drum section was formed in the circumference of steel axis material of the casting building-up The aforementioned outer layer C:1.0 - 2.5%, Si:0.3-1.5%, Mn:0.3-1.5%, Cr: 4.0-8.0%, Mo:4.0-8.0%, V:3.0 - 8.0%, W:2.0 - 6.0%, Nb:0.1-2.0%, Co:0.5-8.0%, aluminum: 0.05-0.5%, B:0.05 - 0.5%, N:0.02 - 1.0%, and the remainder are the compound roll for rolling excellent in the abrasion resistance, surface deterioration-proof nature, etc. characterized by the bird clapper from the iron machine alloy which is Fe substantially.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates to improvement of the roll for rolling which has the composite construction of the axis material and outer layer (roll drum section) which are used as work rolls, such as a hot strip mill.
[0002]
[Description of the Prior Art] To be what is excellent in the abrasion resistance on the front face of a drum section, surface deterioration nature, etc., and can maintain a smooth and healthy surface state stably while the work roll in a hot strip mill has sufficient tough nature which can resist the bending of a rolling load because of reservation of efficient execution of rolling operation and the rolling quality of a rolled steel-ed etc. is demanded. The compound roll which formed the roll-axis core part and the drum section by different **** as a roll for rolling for this is used. While this forms a roll-axis core part by structural steels, such as steel casting and forged steel, and secures necessary mechanical strength etc., it means obtaining high abrasion resistance with the application of the hard material which contained carbide formation elements (W, V, Nb, etc.) abundantly, such as tool steel and high-speed steel, to the drum section (outer layer section) in contact with a rolled stock-ed.
[0003] The above-mentioned compound roll is manufactured by carrying out the casting building-up of the outer layer to the circumference of axis material. a casting building-up (the so-called CPC casting) -- a funnel -- axis material is set in the mould which has arranged the cooled type on the same axle and was assembled by the lower part of a ** fireproof frame, the alloy molten metal for outer layer formation prepared separately is cast in a mould, the circumference of axis material is surrounded by the molten metal, and it is carried out by dropping axis material gradually in the state The molten metal cast in the mould is interlocked with downward operation of axis material, and descends with axis material. The solidification of a molten metal advances in the downward process, and the outer layer which surrounds the circumference of axis material is formed. Heat treatment (hardening / tempering processing) for making the material property based on the component composition **** to an outer layer is performed after the outer layer formation by the casting building-up, subsequently machining is added, and a product roll is made.
[0004]
[Problem(s) to be Solved by the Invention] In the solidification process in the casting building-up of component systems, such as tool steel and high-speed steel, which forms the outer layer of the above-mentioned compound roll, an austenite crystallizes as a primary phase and, subsequently crystallizes as MC system carbide, such as Nb and V, being eutectic in an austenite. The crystallization carbide presents a remarkable uneven distribution big and rough. In order to carry out dissolution disappearance of these big and rough crystallization carbide all over a base, it is necessary to perform heating maintenance by the pyrosphere exceeding about 1150 degrees C. However, it is not necessarily easy to carry out the heat treatment with the existing facility. Carrying out prolonged heating maintenance of the compound roll also becomes the cause of degrading material properties, such as intensity of axis material which consists of steel casting, forged steel, etc., about it and at such high temperature. For this reason, it is difficult to fully attain hardening / tempering processing, and it cannot fully raise the abrasion resistance of an outer layer as a result. this invention is made for the purpose of solving the above-mentioned problem about the roll for rolling which has a composite construction.
[0005]
[Means for Solving the Problem] In the compound roll for rolling by which, as for this invention, building-up

casting of the outer layer was carried out around steel shaft material An outer layer C:1.0 - 2.5%, Si:0.3-1.5%, Mn:0.3-1.5%, Cr: 4.0-8.0%, Mo:4.0-8.0%, V:3.0 - 8.0%, The remainder is characterized by the bird clapper from the iron machine alloy which is Fe substantially W:2.0 - 6.0%, Nb:0.1-2.0%, Co:0.5-8.0%, aluminum:0.05-0.5%, B:0.05 - 0.5%, and N:0.02 to 1.0%.

[0006]

[Function] The outer layer formed in the surroundings of axis material of a casting building-up presents the cast structure distributed minutely [carbide] and uniformly. This is an effect based on being the component composition which carries out compound content of the specified quantity of aluminum, B, and N. Namely, in the casting solidification process of the outer layer, MC system carbide carries out distributed crystallization minutely as a primary phase, and crystallization of an austenite advances by using the detailed carbide as a nucleus. Although M6 C carbide, such as an austenite, Mo, and W, crystallizes as eutectic following crystallization of an austenite, the carbide also presents a detailed crystallization gestalt. For this reason, it becomes possible big and rough for the difficulty of heat treatment of making carbide dissolving all over a base unlike the case of the cast structure which presents an uneven distribution to be mitigated sharply, and to make an outer layer discover the original high abrasiveness based on the constituent by the usual hardening / tempering processing of MC system carbide.

[0007] The reason for component limitation of the outer layer material of this invention is as follows. % which shows a content is weight %.

C:1.0 - 2.5%C combines with Cr, V, W, Mo, etc., and is hard MC system and M7 C3. Carbide, such as a system, is formed and abrasion resistance is raised. Unless it fills a content to 1.0%, the amounts of formation of carbide run short and high abrasion resistance cannot be obtained. On the other hand, if 2.5% is exceeded, by superfluous generation of carbide, toughness will fall and heat-resistant crack nature etc. will become bad.

[0008] Si: Si is added as a deoxidation element in the ingot process of an alloy 0.3 to 1.5%. At less than 0.3%, if the deoxidation effects run short and 1.5% of another side is crossed, the embrittlement of an alloy will be caused.

[0009] Mn: 0.3 - 1.5%Mn has the operation which sets to MnS S which is deacidification and an impure part, and makes it fixed harmless. Although 0.3% or more is needed in order to acquire this effect, if 1.5% is exceeded, the amount of retained austenites will increase and the fall of a degree of hardness will be caused.

[0010] Cr: 4.0-8.0%Cr raises abrasion resistance by combining with C and forming hard carbide while carrying out solid solution strengthening of the base. If it does not fill to 4.0%, the effect runs short, and if 8.0% of another side is crossed, the fall of toughness will be caused by big-and-rough-izing and superfluous generation of Cr carbide. Moreover, big and rough carbide is the system use process of a roll, tends to produce the chip omission from the surface section, and worsens surface deterioration-proof nature of a roll.

[0011] Mo: 4.0 - 8.0%Mo dissolves all over a base, and takes effect to improvement in hardenability and an elevated-temperature property. Moreover, it combines with C, Mo carbide is formed, and it contributes to wear-resistant improvement. At less than 4.0%, the improvement effects of hardenability run short, there are also few amounts of brown coal ghost generation, and the wear-resistant improvement effect is also scarce. If 8.0% is exceeded, it becomes supersaturation, and the amount of retained austenites will be stable and it will become difficult to fully raise a base degree of hardness.

[0012] V:3.0 - 8.0%V combines with C, forms detailed hard VC carbide, and does higher efficacy so to wear-resistant improvement. At less than 3.0%, if there are few the effects and they exceed 8.0%, the fall of toughness will be caused with superfluous generation of carbide. Moreover, the nonuniformity of a distribution of carbide increases and also fault, such as becoming easy to produce oxidization of a molten metal, is produced.

[0013] W:2.0 - 6.0%W combines with C, forms WC carbide of a high degree of hardness, and raises abrasion resistance and a high temperature strength. In order to acquire this effect, 2.0% or more is needed. If 6.0% is exceeded, the fall of the toughness accompanying superfluous generation of carbide will be caused.

[0014] Nb: 0.1-2.0%Nb combines with C, forms the detailed NbC carbide of a high degree of hardness, and contributes to wear-resistant improvement greatly. At less than 0.1%, if there are few the effects and they exceed 2.0%, by superfluous generation of carbide, the fall of toughness will be caused, the nonuniformity of a distribution of carbide will become strong, and fault, such as becoming easy to produce oxidization of a molten metal, will arise.

[0015] Co: 0.5-8.0%Co contributes to improvement in the intensity and the degree of hardness in a pyrosphere

while it dissolves on a base and raises resistance-to-temper-softening nature. This effect is acquired by 0.5% or more. However, the fall of hardenability will be caused if 8.0% is exceeded.
[0016] The outer layer component of the compound roll of this invention contains aluminum, B, and N complexly with many above-mentioned elements. Compound content of these three elements is a matter by which this invention is characterized most.
aluminum: 0.05 - 0.5%aluminum is an element which has powerful deacidification. By adding aluminum to the molten metal in front of tapping by which deoxidation processing was carried out from Si, Mn, etc., the amount of oxygen of a molten metal is reduced further, and the soundness of a product is raised. Moreover, the detailed oxide (aluminum 2O3) generated in a molten metal acts as a crystalline nucleus, and makes a casting solidification structure detailed. At less than 0.05%, if there are few these effects and they exceed 0.5%, a generation oxide will turn big and rough, will turn into inclusion, and will worsen cleanliness of an organization.
[0017] While B:0.05 - 0.5%B has strong deacidification like Above aluminum, being added by the molten metal in front of tapping and reducing the amount of oxygen in a molten metal, the generation oxide (B-2 O3) is contributed to detailed-ization of a casting solidification structure as a crystalline nucleus. Furthermore, hardenability increases by addition of B and the hardening effect can be heightened to the interior of outer layer material. At less than 0.05%, if the effect does not exist and 0.5% of another side is crossed, the fall of toughness will be caused.
[0018] N:0.02 - 1.0%N combines with aluminum in a molten metal etc., forms a nitride, bars austenite grain growth big and rough-ization as a grain-growth inhibitor, and contributes to detailed-ization of a cast structure. If there are few these effects when fewer than 0.02%, and 1.0% is exceeded, the fall of toughness will be caused by superfluous generation of a nitride.
[0019] The iron machine alloy which forms an outer layer consists of Fe substantially except for many above-mentioned elements. P, S, etc. are impure -- a part -- the mixture within the limits which accompany unescapable on the usual ingot technology is permitted, and the meaning which is this invention is not spoiled by mixture of 0.05% or less of P, 0.03% or less of S, etc.
[0020] The axis material (steel) of the compound roll of this invention should just carry out selection use of the thing of **** which has the tough nature which can resist a bending operation required as rolls for rolling, such as steel casting (JIS G5111 SCCrM etc.), forged steel (JIS G4105 SCN, JIS G4103 SNCM, etc.), and carbon steel, a low alloy steel for machine structures, suitably according to a system service condition. What is necessary is just to perform formation of an outer layer (roll drum section) to axis material according to the conventional method of a casting building-up. Heat treatment for making an outer layer discover predetermined material properties (abrasion resistance etc.) is performed after formation of the outer layer by the casting building-up.
[0021] The above-mentioned heat treatment performs hardening cooled by water cooling or forced-air cooling after heating maintenance at 1000-1100 degrees C, and it is attained by carrying out annealing at 500-580 degrees C 2 to 3 times after that. By the above-mentioned hardening / tempering processing, the organization of an outer layer turns into an organization which the secondary eutectoid carbide distributed minutely uniformly to the matrix of tempered martensite or a tempering bainite phase at Crystallization MC and the M6 C carbide row.
[0022]
[Example] After carrying out the casting building-up of the outer layer by making the pillar object made from steel casting into axis material, hardening / tempering processing is performed, appropriate back machining is performed, and a product roll is made.
Roll size: They are after heating maintenance and forced-air cooling to ****:SCN440 outer-layer alloy composition:table 1 reference hardening processing:1000-1100 degree C of 700mm of outer layer shell diameters, 1800mm of drum length, diameter of axis 550 mm, and axis material.
Tempering processing: Cool after 12Hr heating maintenance and among a furnace to 500 - 580 **. 2 times repetition implementation.
[0023] It combines with the outer layer component of each sample offering roll, and the measurement result of outer layer surface hardness (HS) is shown in Table 1. Front Naka and No.1-4 It is an example of invention and No.11 -13 are an example of comparison from which the content (front Naka underline) of one of elements has separated from the convention of this invention. Drawing 1 shows the degree-of-hardness change by the

temperature of an outer layer about test-specimen No.1 (example of invention), and No.11 (example of comparison). The field in drawing (T) is a temperature requirement to which the drum section front face of the work roll of the finishing rolling stand in a hot strip mill goes up during rolling operation. example No.of invention 1, and example No.of comparison 11 of the conventional material the degree of hardness in ordinary temperature -- abbreviation -- although it is the same -- example No.of comparison 11 To the degree of hardness falling greatly in connection with a heating temperature up, there are few degree-of-hardness falls of example No.of invention 1, and they are maintaining the high degree of hardness also under the system temperature condition of a hot-rolling roll.

[0024] Drawing 2 (1) : Etching and scale-factor x400]. - (3) The organization of the outer layer material of example No.of invention 1 is shown, and it is drawing 3 (1). - (3) Example No.of comparison 11 [each drawing showing the organization of outer layer material is (1). : No-etching, scale-factor x100, (2) : Etching, scale-factor x100, (3) Drawing 2 (1) By [no etching], MC system carbide (NbC, VC, etc.) crystallized as a primary phase in the solidification process of a casting building-up is observed, and it is drawing 3 (1). By [no etching], MC carbide crystallized as eutectic in the solidification process of a casting building-up is observed. drawing 2 (2), (3), and drawing 3 (2) and (3) moreover, [-- the black portion in etching organization] is a base organization which consists of tempered martensite and a tempered bainite, and the white portion shows existence of crystallization carbide and a secondary eutectoid carbide for all compared with the conventional material [drawing 3 (1)], the outer layer organization [drawing 2 (1)] of the example of invention is remarkably detailed and homogeneous, and the difference among both clear-comes out of it so that it may be contrasted with drawing 2 and drawing 3

[0025] System use was presented with each sample offering roll as a work roll in the finishing stand of a hot strip mill. The abrasion loss (mm) and surface roughness (Rmax) of an outer layer were measured after the above-mentioned use examination, and the result shown in **** of Table 1 was obtained. Compared with example No.of comparison11 -13, the wear and surface deterioration of an outer layer in the example of invention are the slight and improved abrasion resistance. It turns out that it has surface deterioration-proof nature.

[0026]

[Table 1]

No	外層の化学組成 (Wt%)														硬度 (Hs)	実機使用試験			
	C	Si	Mn	P	S	Cr	Mo	V	W	Nb	Co	Al	B	N		圧延量 (Ton)	表面粗度 (R max)	摩耗量 (mm)	
1	1.89	0.71	0.66	0.030	0.017	5.16	5.14	6.68	3.81	0.69	1.88	0.21	0.13	0.05	85	903	3.6	0.046	発明例
2	1.48	0.65	0.81	0.023	0.022	6.92	6.81	6.03	5.71	1.55	3.01	0.35	0.23	0.09	83	1065	5.0	0.049	発明例
3	2.24	0.59	0.99	0.039	0.011	4.11	4.01	7.00	2.03	1.84	4.23	0.29	0.11	0.02	83	1020	4.6	0.048	発明例
4	1.21	0.88	0.59	0.044	0.009	5.99	7.88	4.11	2.09	0.33	1.24	0.11	0.40	0.04	84	1115	3.9	0.044	発明例
11	2.01	0.60	0.71	0.033	0.021	5.03	4.98	5.52	4.03	1.22	1.55	0.02	0.02	0.05	84	983	8.3	0.079	比較例
12	1.68	0.73	0.69	0.023	0.015	4.46	6.11	6.99	6.00	0.88	2.99	0.44	0.01	0.01	83	1296	11.2	0.116	比較例
13	2.19	0.66	0.55	0.028	0.017	6.02	5.67	4.22	2.54	1.73	4.11	0.01	0.38	0.03	82	1100	9.6	0.081	比較例

[0027]
[Effect of the Invention] the compound roll for rolling of this invention has the detailed cast structure of the outer layer (drum section) by which a casting building-up is carried out to axis material -- it is homogeneous, high abrasion resistance, surface deterioration-proof nature, etc. are secured by hardening and annealing as the effect, and the useful life longevity of a roll improves, and it contributes to improvement in the increase in efficiency of rolling operation, and the rolling quality of a rolled stock-ed etc. -- it is a thing

---

[Translation done.]

* NOTICES *

TECHNICAL FIELD

[Industrial Application] this invention relates to improvement of the roll for rolling which has the composite construction of the axis material and outer layer (roll drum section) which are used as work rolls, such as a hot strip mill.

[Translation done.]

PRIOR ART

[Description of the Prior Art] To be what is excellent in the abrasion resistance on the front face of a drum section, surface deterioration nature, etc., and can maintain a smooth and healthy surface state stably while the work roll in a hot strip mill has sufficient tough nature which can resist the bending of a rolling load because of reservation of efficient execution of rolling operation and the rolling quality of a rolled steel-ed etc. is demanded. The compound roll which formed the roll-axis core part and the drum section by different **** as a roll for rolling for this is used. While this forms a roll-axis core part by structural steels, such as steel casting and forged steel, and secures necessary mechanical strength etc., it means obtaining high abrasion resistance with the application of the hard material which contained carbide formation elements (W, V, Nb, etc.) abundantly, such as tool steel and high-speed steel, to the drum section (outer layer section) in contact with a rolled stock-ed.

[0003] The above-mentioned compound roll is manufactured by carrying out the casting building-up of the outer layer to the circumference of axis material. a casting building-up (the so-called CPC casting) -- a funnel -- axis material is set in the mould which has arranged the cooled type on the same axle and was assembled by the lower part of a ** fireproof frame, the alloy molten metal for outer layer formation prepared separately is cast in a mould, the circumference of axis material is surrounded by the molten metal, and it is carried out by dropping axis material gradually in the state The molten metal cast in the mould is interlocked with downward operation of axis material, and descends with axis material. The solidification of a molten metal advances in the downward process, and the outer layer which surrounds the circumference of axis material is formed. Heat treatment (hardening / tempering processing) for making the material property based on the component composition **** to an outer layer is performed after the outer layer formation by the casting building-up, subsequently machining is added, and a product roll is made.

[Translation done.]

* NOTICES *

1. This document has been translated by computer.So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3.In the drawings, any words are not translated.

EFFECT OF THE INVENTION

[Effect of the Invention] the compound roll for rolling of this invention has the detailed cast structure of the outer layer (drum section) by which a casting building-up is carried out to axis material -- it is homogeneous, high abrasion resistance, surface deterioration-proof nature, etc. are secured by hardening and annealing as the effect, and the useful life longevity of a roll improves, and it contributes to improvement in the increase in efficiency of rolling operation, and the rolling quality of a rolled stock-ed etc. -- it is a thing

---

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] In the solidification process in the casting building-up of component systems, such as tool steel and high-speed steel, which forms the outer layer of the above-mentioned compound roll, an austenite crystallizes as a primary phase and, subsequently crystallizes as MC system carbide, such as Nb and V, being eutectic in an austenite. The crystallization carbide presents a remarkable uneven distribution big and rough. In order to carry out dissolution disappearance of these big and rough crystallization carbide all over a base, it is necessary to perform heating maintenance by the pyrosphere exceeding about 1150 degrees C. However, it is not necessarily easy to carry out the heat treatment with the existing facility. Carrying out prolonged heating maintenance of the compound roll also becomes the cause of degrading material properties, such as intensity of axis material which consists of steel casting, forged steel, etc., about it and at such high temperature. For this reason, it is difficult to fully attain hardening / tempering processing, and it cannot fully raise the abrasion resistance of an outer layer as a result. this invention is made for the purpose of solving the above-mentioned problem about the roll for rolling which has a composite construction.

[Translation done.]

MEANS

[Means for Solving the Problem] In the compound roll for rolling by which, as for this invention, building-up casting of the outer layer was carried out around steel shaft material An outer layer C:1.0 - 2.5%, Si:0.3-1.5%, Mn:0.3-1.5%, Cr: 4.0-8.0%, Mo:4.0-8.0%, V:3.0 - 8.0%, The remainder is characterized by the bird clapper from the iron machine alloy which is Fe substantially W:2.0 - 6.0%, Nb:0.1-2.0%, Co:0.5-8.0%, aluminum:0.05-0.5%, B:0.05 - 0.5%, and N:0.02 to 1.0%.

[Translation done.]

OPERATION

[Function] The outer layer formed in the surroundings of axis material of a casting building-up presents the cast structure distributed minutely [carbide] and uniformly. This is an effect based on being the component composition which carries out compound content of the specified quantity of aluminum, B, and N. Namely, in the casting solidification process of the outer layer, MC system carbide carries out distributed crystallization minutely as a primary phase, and crystallization of an austenite advances by using the detailed carbide as a nucleus. Although M6 C carbide, such as an austenite, Mo, and W, crystallizes as eutectic following crystallization of an austenite, the carbide also presents a detailed crystallization form. For this reason, it becomes possible big and rough for the difficulty of heat treatment of making carbide dissolving all over a base unlike the case of the cast structure which presents an uneven distribution to be mitigated sharply, and to make an outer layer discover the original high abrasiveness based on the constituent by the usual hardening / tempering processing of MC system carbide.

[0007] The reason for component limitation of the outer layer material of this invention is as follows. % which shows a content is weight %.

C:1.0 - 2.5%C combines with Cr, V, W, Mo, etc., and is hard MC system and M7 C3. Carbide, such as a system, is formed and abrasion resistance is raised. Unless it fills a content to 1.0%, the amounts of formation of carbide run short and high abrasion resistance cannot be obtained. On the other hand, if 2.5% is exceeded, by superfluous generation of carbide, toughness will fall and heat-resistant crack nature etc. will become bad.

[0008] Si: Si is added as a deoxidation element in the ingot process of an alloy 0.3 to 1.5%. At less than 0.3%, if the deoxidation effects run short and 1.5% of another side is crossed, the embrittlement of an alloy will be caused.

[0009] Mn: 0.3 - 1.5%Mn has the operation which sets to MnS S which is deacidification and an impure part, and makes it fixed harmless. Although 0.3% or more is needed in order to acquire this effect, if 1.5% is exceeded, the amount of retained austenites will increase and the fall of a degree of hardness will be caused.

[0010] Cr: 4.0-8.0%Cr raises abrasion resistance by combining with C and forming hard carbide while carrying out solid solution strengthening of the base. If it does not fill to 4.0%, the effect runs short, and if 8.0% of another side is crossed, the fall of toughness will be caused by big-and-rough-izing and superfluous generation of Cr carbide. Moreover, big and rough carbide is the system use process of a roll, tends to produce the chip omission from the surface section, and worsens surface deterioration-proof nature of a roll.

[0011] Mo: 4.0 - 8.0%Mo dissolves all over a base, and takes effect to improvement in hardenability and an elevated-temperature property. Moreover, it combines with C, Mo carbide is formed, and it contributes to wear-resistant improvement. At less than 4.0%, the improvement effects of hardenability run short, there are also few amounts of brown coal ghost generation, and the wear-resistant improvement effect is also scarce. If 8.0% is exceeded, it becomes supersaturation, and the amount of retained austenites will be stable and it will become difficult to fully raise a base degree of hardness.

[0012] V:3.0 - 8.0%V combines with C, forms detailed hard VC carbide, and does higher efficacy so to wear-resistant improvement. At less than 3.0%, if there are few the effects and they exceed 8.0%, the fall of toughness will be caused with superfluous generation of carbide. Moreover, the nonuniformity of a distribution of carbide increases and also fault, such as becoming easy to produce oxidization of a molten metal, is produced.

[0013] W:2.0 - 6.0%W combines with C, forms WC carbide of a high degree of hardness, and raises abrasion resistance and a high temperature strength. In order to acquire this effect, 2.0% or more is needed. If 6.0% is exceeded, the fall of the toughness accompanying superfluous generation of carbide will be caused.

[0014] Nb: 0.1-2.0%Nb combines with C, forms the detailed NbC carbide of a high degree of hardness, and contributes to wear-resistant improvement greatly. At less than 0.1%, if there are few the effects and they exceed 2.0%, by superfluous generation of carbide, the fall of toughness will be caused, the nonuniformity of a distribution of carbide will become strong, and fault, such as becoming easy to produce oxidization of a molten metal, will arise.
[0015] Co: 0.5-8.0%Co contributes to improvement in the intensity and the degree of hardness in a pyrosphere while it dissolves on a base and raises resistance-to-temper-softening nature. This effect is acquired by 0.5% or more. However, the fall of hardenability will be caused if 8.0% is exceeded.
[0016] The outer layer component of the compound roll of this invention contains aluminum, B, and N complexly with many above-mentioned elements. Compound content of these three elements is a matter by which this invention is characterized most.
aluminum: 0.05 - 0.5%aluminum is an element which has powerful deacidification. By adding aluminum to the molten metal in front of tapping by which deoxidation processing was carried out from Si, Mn, etc., the amount of oxygen of a molten metal is reduced further, and the soundness of a product is raised. Moreover, the detailed oxide (aluminum 2O3) generated in a molten metal acts as a crystalline nucleus, and makes a casting solidification structure detailed. At less than 0.05%, if there are few these effects and they exceed 0.5%, a generation oxide will turn big and rough, will turn into inclusion, and will worsen cleanliness of an organization.
[0017] While B:0.05 - 0.5%B has strong deacidification like Above aluminum, being added by the molten metal in front of tapping and reducing the amount of oxygen in a molten metal, the generation oxide (B-2 O3) is contributed to detailed-ization of a casting solidification structure as a crystalline nucleus. Furthermore, hardenability increases by addition of B and the hardening effect can be heightened to the interior of outer layer material. At less than 0.05%, if the effect does not exist and 0.5% of another side is crossed, the fall of toughness will be caused.
[0018] N:0.02 - 1.0%N combines with aluminum in a molten metal etc., forms a nitride, bars austenite grain growth big and rough-ization as a grain-growth inhibitor, and contributes to detailed-ization of a cast structure. If there are few these effects when fewer than 0.02%, and 1.0% is exceeded, the fall of toughness will be caused by superfluous generation of a nitride.
[0019] The iron machine alloy which forms an outer layer consists of Fe substantially except for many above-mentioned elements. P, S, etc. are impure -- a part -- the mixture within the limits which accompany unescapable on the usual ingot technology is permitted, and the meaning which is this invention is not spoiled by mixture of 0.05% or less of P, 0.03% or less of S, etc.
[0020] The axis material (steel) of the compound roll of this invention should just carry out selection use of the thing of **** which has the tough nature which can resist a bending operation required as rolls for rolling, such as steel casting (JIS G5111 SCCrM etc.), forged steel (JIS G4105 SCN, JIS G4103 SNCM, etc.), and carbon steel, a low alloy steel for machine structures, suitably according to a system service condition. What is necessary is just to perform formation of an outer layer (roll drum section) to axis material according to the conventional method of a casting building-up. Heat treatment for making an outer layer discover predetermined material properties (abrasion resistance etc.) is performed after formation of the outer layer by the casting building-up.
[0021] The above-mentioned heat treatment performs hardening cooled by water cooling or forced-air cooling after heating maintenance at 1000-1100 degrees C, and it is attained by carrying out annealing at 500-580 degrees C 2 to 3 times after that. By the above-mentioned hardening / tempering processing, the organization of an outer layer turns into an organization which the secondary eutectoid carbide distributed minutely uniformly to the matrix of tempered martensite or a tempering bainite phase at Crystallization MC and the M6 C carbide row.

[Translation done.]

EXAMPLE

[Example] After carrying out the casting building-up of the outer layer by making the pillar object made from steel casting into axis material, hardening / tempering processing is performed, appropriate back machining is performed, and a product roll is made.
Roll size: They are after heating maintenance and forced-air cooling to ****:SCN440 outer-layer alloy composition:table 1 reference hardening processing:1000-1100 degree C of 700mm of outer layer shell diameters, 1800mm of drum length, diameter of axis 550 mm, and axis material.
Tempering processing: Cool after 12Hr heating maintenance and among a furnace to 500 - 580 **. 2 times repetition implementation.
[0023] It combines with the outer layer component of each sample offering roll, and the measurement result of outer layer surface hardness (HS) is shown in Table 1. Front Naka and No.1-4 It is an example of invention and No.11 -13 are an example of comparison from which the content (front Naka underline) of one of elements has separated from the convention of this invention. Drawing 1 shows the degree-of-hardness change by the temperature of an outer layer about test-specimen No.1 (example of invention), and No.11 (example of comparison). The field in drawing (T) is a temperature requirement to which the drum section front face of the work roll of the finishing rolling stand in a hot strip mill goes up during rolling operation. example No.of invention 1, and example No.of comparison 11 of the conventional material the degree of hardness in ordinary temperature -- abbreviation -- although it is the same -- example No.of comparison 11 To the degree of hardness falling greatly in connection with a heating temperature up, there are few degree-of-hardness falls of example No.of invention 1, and they are maintaining the high degree of hardness also under the system temperature condition of a hot-rolling roll.
[0024] Drawing 2 (1) : Etching and scale-factor x400]. - (3) The organization of the outer layer material of example No.of invention 1 is shown, and it is drawing 3 (1). - (3) Example No.of comparison 11 [each drawing showing the organization of outer layer material is (1). : No-etching, scale-factor x100, (2) : Etching, scale-factor x100, (3) Drawing 2 (1) By [no etching], MC system carbide (NbC, VC, etc.) crystallized as a primary phase in the solidification process of a casting building-up is observed, and it is drawing 3 (1). By [no etching], MC carbide crystallized as eutectic in the solidification process of a casting building-up is observed. drawing 2 (2), (3), and drawing 3 (2) and (3) moreover, [-- the black portion in etching organization] is a base organization which consists of tempered martensite and a tempered bainite, and the white portion shows existence of crystallization carbide and a secondary eutectoid carbide for all compared with the conventional material [drawing 3 (1)], the outer layer organization [drawing 2 (1)] of the example of invention is remarkably detailed and homogeneous, and the difference among both clear-comes out of it so that it may be contrasted with drawing 2 and drawing 3
[0025] System use was presented with each sample offering roll as a work roll in the finishing stand of a hot strip mill. The abrasion loss (mm) and surface roughness (Rmax) of an outer layer were measured after the above-mentioned use examination, and the result shown in **** of Table 1 was obtained. Compared with example No.of comparison11 -13, the wear and surface deterioration of an outer layer in the example of invention are the slight and improved abrasion resistance. It turns out that it has surface deterioration-proof nature.
[0026]
[Table 1]

No	外層の化学組成 (Wt%)														硬度 (Hs)	実機使用試験			
	C	Si	Mn	P	S	Cr	Mo	V	W	Nb	Co	Al	B	N		圧延量 (Tθn)	表面粗度 (R max)	摩耗量 (mm)	
1	1.89	0.71	0.66	0.030	0.017	5.16	5.14	6.68	3.81	0.69	1.88	0.21	0.13	0.05	85	903	3.6	0.046	発明例
2	1.48	0.65	0.81	0.023	0.022	6.92	6.81	6.03	5.71	1.55	3.01	0.35	0.23	0.09	83	1065	5.0	0.049	
3	2.24	0.59	0.99	0.039	0.011	4.11	4.01	7.00	2.03	1.84	4.23	0.29	0.11	0.02	83	1020	4.6	0.048	
4	1.21	0.88	0.59	0.044	0.009	5.99	7.88	4.11	2.09	0.33	1.24	0.11	0.40	0.04	84	1115	3.9	0.044	
11	2.01	0.60	0.71	0.033	0.021	5.03	4.98	5.52	4.03	1.22	1.55	0.02	0.02	0.05	84	983	8.3	0.079	比較例
12	1.68	0.73	0.69	0.023	0.015	4.46	6.11	6.99	6.00	0.88	2.99	0.44	0.01	0.01	83	1296	11.2	0.116	
13	2.19	0.66	0.55	0.028	0.017	6.02	5.67	4.22	2.54	1.73	4.11	0.01	0.38	0.03	82	1190	9.6	0.681	

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the graph which showed the relation between the surface hardness of the outer layer material of a compound roll, and temperature.
[Drawing 2] [said drawing (1):no etching which is the drawing substitution microphotography in which the metal texture of the outer layer of the roll of this invention is shown, a scale factor 100, this drawing (2): Etching, a scale factor 100, said drawing (3):en CHINGU, scale-factor 400].
[Drawing 3] [said drawing (1):no etching which is the drawing substitution microphotography in which the metal texture of the outer layer of the conventional roll is shown, a scale factor 100, this drawing (2): Etching, a scale factor 100, said drawing (3):en CHINGU, scale-factor 400].

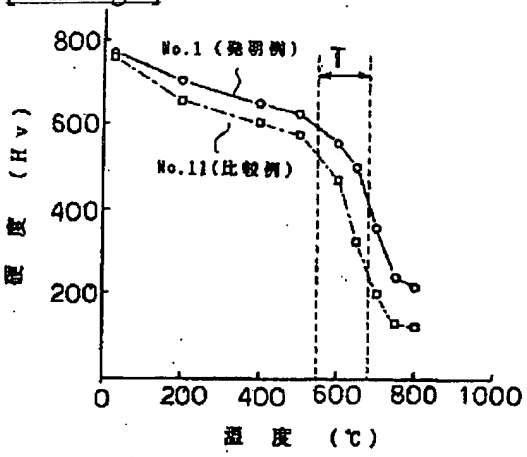
[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

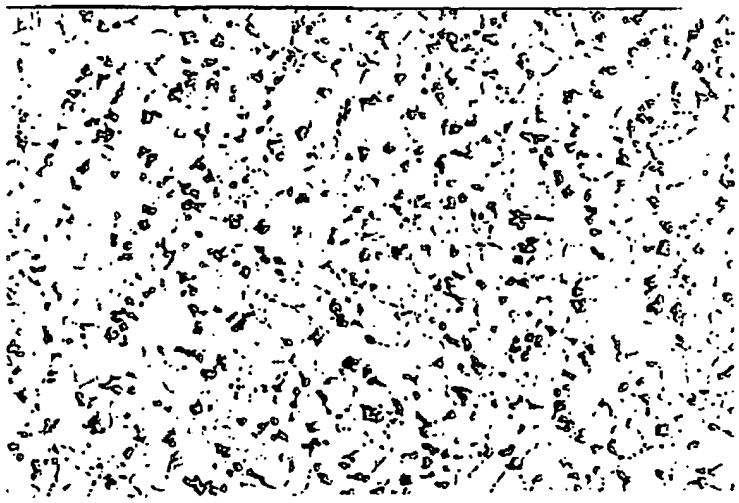
DRAWINGS

[Drawing 1]

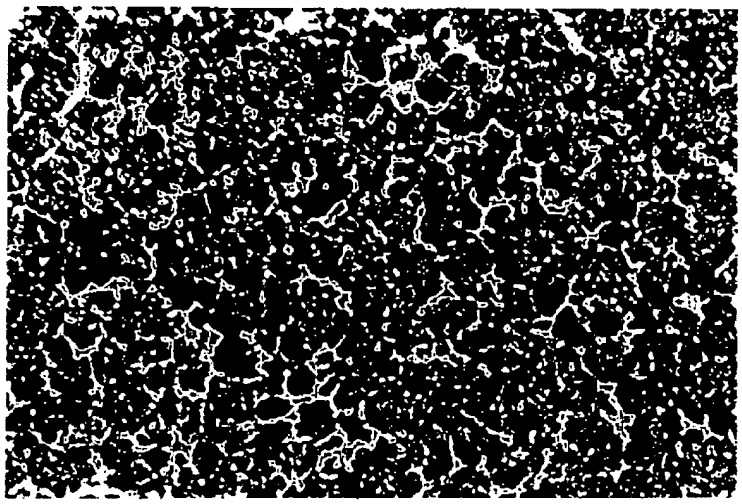


[Drawing 2]

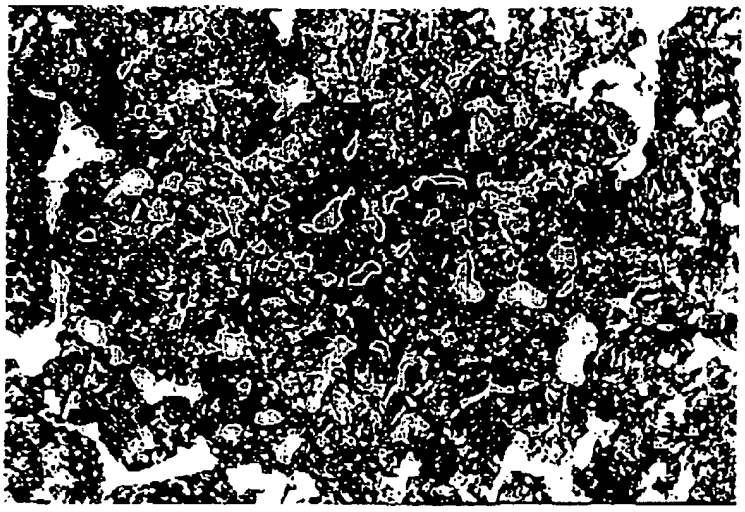
(1)



(2)



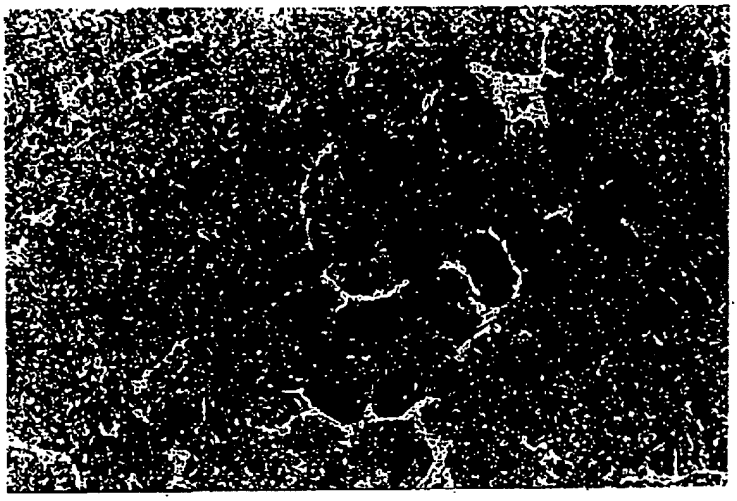
(3)



[Drawing 3]

(1)

(2)



(3)

[Translation done.]